Canadian Institute of Nuclear Physics
Institut canadien de physique nucléaire

Newsletter #22, May 2023

The Canadian Institute of Nuclear Physics (CINP) is a formal organization of the Canadian nuclear physics research community to promote excellence in nuclear research and education, and to advocate the interests and goals of the community both domestically and abroad.

1. Upcoming CINP Sessions at CAP Congress

The CINP and IPP are once again hosting a joint session at the CAP Congress, being held in person at the University of New Brunswick in Fredricton, NB.

Time	Event
TBA	**CINP Board Meeting** (by invitation only)
Thursday, June 22, 2023	
	CINP+IPP Joint Session
10:30	NSERC SAPES Report (20+5)
10:55	CFI Report (10+5)
11:10	TRIUMF Report (20+5)
11:35	SNOLab Report (15+5)
11:55	Pan-Canadian MRS Technical Coordination Board (10+5)
12:15	**CINP Annual General Meeting** (be sure to select your lunch option)

2. CINP Individual Membership

CINP membership is up modestly from last year. Through to May 1, there were 3 new faculty members and 8 new associates. This was partly offset by a loss of 2 faculty and 6 associate members (as part of our regular review process to ensure the roster remains up-to-date). Furthermore, there was one transfer from associate to faculty membership, and one transfer from faculty to associate. The net membership gain is 3.

Please encourage your colleagues, grad students and PDFs to join and contribute to the activities of the Scientific Working Groups (SWGs). The membership form and introduction letter are posted at:
http://cinp.ca/membership

CINP Individual Membership – May 1, 2023			
Total Membership	173 (+3)	Nuclear Astrophysics SWG	70 (-2)
Faculty-class Members	87 (+1)	Nuclear Structure SWG	75 (+1)
Associate Members	86 (+2)	Fundamental Symmetries SWG	79 (+6)
Experimentalists	127 (0)	Hadronic Physics/QCD SWG	58 (+4)
Theorists	44 (+3)	Nuclear Theory SWG	32 (+5)
		Education & Training SWG	54 (+4)

3. Representation and Input to Various Agencies

The CINP is an advocate and representative of the Canadian nuclear physics community and is asked to attend various meetings or make presentations on its behalf. Some recent and forthcoming activities include:

- The Subatomic Physics Evaluation Section (SAPES) continued their new schedule, which was substantially revised a year ago. The CINP presentation that normally would take place at the beginning of Large Projects Day took place at the Fall Context Session on Dec 12/22. Thanks to those CINP members who provided scientific updates that were shown there. GH also attended the virtual SAPES Large Projects Day as an observer on Sunday Feb 19/23. This meeting is now entirely in-camera, upon request of the international SAPES members. We hope that SAPES competition week will return to an in-person format soon.

- Every spring, the CINP Executive Director is asked to suggest new members of the NSERC Subatomic Physics Evaluation Section (SAPES), to replace the specific expertise of outgoing members. **If you have suggestions for new members for the 2023-24 competition, please respond to GH ASAP.**

Retiring Members:
Alison Lister, University of British Columbia, Exp High Energy Nuclear & Particle Physics

Ingo Wiedenhoever, Florida State University, Exp Nuclear Physics & Astrophysics, Nuclear Reactions

Mary Convery, Fermilab, Exp Accelerator R&D, High Energy Physics

Paul Garrett, University of Guelph, Exp Low Energy Physics

Pedro Vieira, Perimeter Institute, Th Quantum Fields & Strings

Meenakshi Narain, Brown University, Exp High Energy Physics, Hadron Collider

General Future Recruitment:
Exp. Particle Physics & Astrophysics, Dark Matter & High Energy

Exp. Nuclear Physics, Ultracold Neutrons

Th. Particle Physics, Dark Matter & Cosmology

Th. Particle & Nuclear Physics

- GH is also representing CINP on the Pan-Canadian MRS Coordination Board, which is a new national oversight board for all SAP-MRS resources. A new development was the decision to have CINP and IPP Executive Directors join as co-applicants on the Carleton, Guelph, and Victoria MRS grant applications in the 2023 competition, to demonstrate their openness to supporting national infrastructure that is not part of the hosting university. The most recent meeting was on April 24/23. For more information on the available MRS resources, please visit the CINP website https://cinp.ca/subatomic-physics-major-resources-support-facilities

- The Advisory Committee on TRIUMF (ACOT) is a panel of international experts that meets and reports to the NRC twice a year. Garth Huber represents the CINP as a "community observer".GH is the nuclear physics community representative at ACOT (Advisory Committee on TRIUMF) meetings. The first in-person meeting since COVID-19 was on Oct 24-25/22. GH also attended the most recent meeting at TRIUMF on May 10-11/23.

- Nigel Smith, TRIUMF Director, has instituted a regular set of meetings between senior TRIUMF leadership and the Directors of CINP, IPP and McDonald Institute. This is a very positive development. We are trying to meet prior to every ACOT meeting. The most recent meeting was May 2/23.

4. NSERC Support for CINP

NSERC provides funding for many CINP activities through the Subatomic Physics Major Resources Support (SAP-MRS) program. The installment for 2022-23 is $75,000.

NSERC CRSNG

5. CINP Undergraduate Research Scholarships (URS)

The 2023 competition for the URS was recently completed. The intent of the program is to allow gifted undergraduates to work with a supervisor on nuclear physics research for 16 weeks this summer. Each URS is valued at $5500, which must be supplemented by the supervisor by at least $4000, to a total of not less than $9500. In addition, a $1300 travel award is available to encourage work at a laboratory, or with a collaborator for an extended period in the summer.

The scholarships were evaluated by a committee: GH, Chair, Juliette Mammei (Manitoba), and Adam Garnsworthy (TRIUMF). Ten scholarship applications were received, which is back to the historic norm. The committee awarded 6 scholarships. Surprisingly, there were no theory applications this year. To be sure that all deserving students had research opportunities, the committee decided to not award any URS tostudents already holding an NSERC USRA.

Student	Supervisor	Project Title
Bui Trang (Manitoba)	Savino Longo (Manitoba)	Ultracold neutron detector for the TUCAN experiment at TRIUMF
Jason Froats (Guelph)	Paul Garrett (Guelph)	Study of beta-decay of ^{110}Ag to ^{110}Cd with GRIFFIN spectrometer
Gabriela Gelinas (Calgary)	Michael Wieser (Calgary)	Development of laser ablation source to assess ^{222}Rn exposure in biological materials
Laura Hubbert (Mt Allison)	David Hornidge (Mt Allison)	Elastic Compton scattering from ^{12}C with the CATS detector
Zachary Saunders (Saint Mary's)	Rituparna Kanungo (Saint Mary's)	Viewing Borromean nuclei with transfer reactions
Zu Ying Yu (SFU)	Krzysztof Starosta (SFU)	Fusion-evaporation reaction rate predictions for TIGRESS and TIGRESS integrate plunger measurements

6. Junior Scientist Travel Support Program (JSci)

The goal of the JSci program is to allow graduate students and PDFs to broaden their research horizons and become more mature scientists. Two types of expenditures are supported:

1) Funding to allow graduate students and PDFs to attend specialized workshops and schools not directly related to their research project, such as workshops or training opportunities on the practical applications of subatomic physics detector techniques, new computer or digitization technologies, advanced computation techniques, or technology transfer training.

2) Funding to enable PDFs to present their work at conferences or workshops. Conferences and workshops already receiving funds from CINP will not be eligible. Preference will be given to international meetings held either in Canada or abroad.

How to Apply:

The application form can be obtained from the CINP website at: https://cinp.ca/junior-scientist-travel-support-program-jsci

Applications are accepted on a continuing basis. A standing committee consisting of: CINP Executive Director, Chair of the Education & Training SWG, and one representative of the CINP Board will evaluate applications as they are submitted and provide prompt feedback or decision to the applicant (typically within 2 weeks).

The total program funds available for 2023-24 are $7000.

7. WNPPC Student Prizes

To commemorate the 60th anniversary of the WNNPC, CINP offered enhanced student prizes. The recipients of the CINP prizes were:

Name	Category	Prize
Alicia Postuma (Regina)	2nd Best Overall	$400
Emma Klemets (UBC)	1st Experiment	$250
Eric Gyabeng Fuakye (Regina)	3rd Experiment	$150
Madeleine Berube (TRIUMF)	Best Poster	$200

8. 2023 WNPPC Graduate Student Travel Awards

With the resumption of in person meetings, we were finally able to resume our travel award program to support students speaking about their nuclear physics research at the WNPPC. The WNPPC travel awards were valued at $650.

There was lots of pent up demand, and the Board was requested to increase the number of awards to keep the success rate near the historic norm of ~65%. 20 applications received, 13 funded (original number was 8). Evaluation Committee: Russell Mammei, Chair (Winnipeg), Barry Davids (TRIUMF), Alexandros Gezerlis (Guelph).

Student	Supervisor	WNPPC Talk Title
Zarin Ahmed (Guelph)	Paul Garrett (Guelph)	Development work for the Detector Array for Energy Measurement of Neutrons (DAEMON)
Soud Al Kharusi (McGill)	Thomas Brunner (McGill)	Mitigating Cosmogenic Backgrounds in nEXO
Fatemeh Gorgannejad (Manitoba)	Wouter Deconinck (Manitoba)	Signal Corrections using Background Detectors in the MOLLER Experiment
Emma Klemets (UBC)	Beatrice Franke (TRIUMF)	Adiabatic transport of ultracold polarized neutrons for the TUCAN EDM experiment
Guy Leckenby (UBC)	Iris Dillmann (TRIUMF)	Bound-state beta-decay of Thallium-205 to constrain s-process predictions for the early Solar System
Matthew Martin (SFU)	Krzysztof Starosta (SFU)	Electromagnetic Transition Rate Studies in ^{28}Mg
Craig McRae (Manitoba)	Peter Blunden (Manitoba)	Global Analysis of the Proton Elastic Form Factors in the Space-Like Region
Muhammad Mubasher (Alberta)	Andrzej Czarnecki (Alberta)	Decay rates of Postronium Species
Alicia Postuma (Regina)	Garth Huber (Regina)	From Spin to Structure: Beam Single-Spin Asymmetry in Exclusive Pion Production
Love Preet (Regina)	Garth Huber (Regina)	Understanding Hadronic Mass through Light Meson Structure at the EIC
Bardh Quni (Manitoba)	Wouter Deconinck (Manitoba)	Background simulations on Charged-Lepton Flavor Violation (CLFV) in the Leptoquark Framework at EIC
Jose Trujillo (Calgary)	Rachid Ouyed (Calgary)	SiRop: Latest Implementations
Frank Wu (SFU)	Corina Andreoiu (SFU)	Searching for Alpha-Cluster States in ^{126}Te

9. CINP Graduate Fellowship

2023 was the third year of the Graduate Fellowship program. We are continuing to re-invest the travel savings due to COVID-19 into additional student scholarships, above our nominal budget of one fellowship. Each fellowship is valued at $12,500, which must be supplemented by the supervisor and/or institution by at least $20,000, to a total of not less than $32,500. The student cannot concurrently hold any other major full-time scholarship or fellowship (defined as $12,000 or higher).

In addition to academic and scientific criteria, the Fellowship award has anEDI component, where applicants had to write a 1 page description of what role a PhD student and CINP Graduate Fellow can play in promoting and advancing EDI in our community.

Nine applications were received, and two fellowships were awarded, so the competition was very tight. The applications were reviewed by the committee: Juliette Mammei, Chair (Manitoba), Jason Holt (TRIUMF), Sangyong Jeon (McGill) and Jeff Martin (Winnipeg). The committee states "the competition this year was incredibly close. Any of the applicants could have won in another year. They were very happy to see the diversity of the applicant pool and were particularly impressed by the quality of the EDI statements." CINP is pleased to announce the two recipients of the 2023 Fellowships:

Gareth Smith (UBC, TRIUMF). He has been working with the ALPHA collaboration towards measuring the gravitational force on trapped antihydrogen atoms, in a direct test of the symmetry between matter and antimatter. Splitting his time between TRIUMF and CERN, his research focuses on the implementation of a time-of-flight scintillator detector. This will reject the background of cosmic rays which otherwise obscures the antihydrogen signal. Gareth works under the supervision of Makoto Fujiwara (TRIUMF).

Alicia Postuma (Regina). Alicia is working on data analysis the KaonLT experiment from Jefferson Lab Hall C, which measured charged meson electroproduction to study QCD in the transition regime. For her PhD thesis, Alicia will analyze data from the u-channel, in which the meson is produced at a backwards angle. This reaction provides novel access to the meson cloud of the proton, specifically the *qqq-qqbar* part of the proton wave function. Results will be compared to different theoretical models to determine the best description of hadronic reactions in the transition regime. Alicia works under the supervision of Garth Huber (Regina).

CINP is very pleased by the strong response to the Graduate Fellowship program, and we thank the many students who applied for the Fellowship, the many people who wrote letters, and the Selection Committee for their work.

10. CINP Conference Support

The CINP extends partial funding to workshops, meetings and conferences of broad relevance to nuclear physics in Canada. Requests are appraised against the mission and goals of the CINP, and funding is contingent upon satisfactorily showing that the event will further the aims of the CINP and be of benefit to its members. Application forms for external conference support are available from https://cinp.ca/conference-support

We hope you will be able to attend the following CINP-sponsored conferences:

- **Gordon Research Seminar and Conference on Nuclear Chemistry**: "Novel Approaches to Study Nuclear Reactions and Structure" (tbc) (GRS) and "Patterns and Reactions of Exotic Nuclei" (GRC). New London, NH, June 10-16, 2023. https://www.grc.org/nuclear-chemistry-conference/2023/
- **Theory Canada 15**. Mt. Allison University, Sackville, NB, June 15-17, 2023. https://dtp.cap.ca/theory-canada/tc-15/
- **13th International Symposium on the Development of Semiconductor Tracking Detectors (HSTD13).** Vancouver, Dec 3-8, 2023. http://indi.to/hstd13

After completion of the Graduate Fellowship, the recipient is asked to provide a short report for the CINP Newsletter summarizing the result of their research. We are pleased to present the articles from the 2022 Graduate Fellowship recipients.

11. Validation of the design for the pion background detector in the MOLLER experiment

Fatemeh Gorgannejad (Manitoba)
PhD Supervisor: Wouter Deconinck (Manitoba)

High-precision measurements of the parity-violating asymmetry (A_{PV}) in electron scattering have extraordinary scientific reach in the field of sub-atomic physics. In the Measurement of a Lepton Lepton Electroweak Reaction (MOLLER) experiment, an 11 GeV longitudinally polarized electron beam with a rapidly flipping spin is directed toward a liquid hydrogen target to measure A_{PV} in electron-electron scattering. As shown in Fig 11-1, after the target, a set of spectrometer systems and collimators separate Møller electrons from the background and transport them to the detector systems: tracking detectors, integrating detectors, and background detectors.

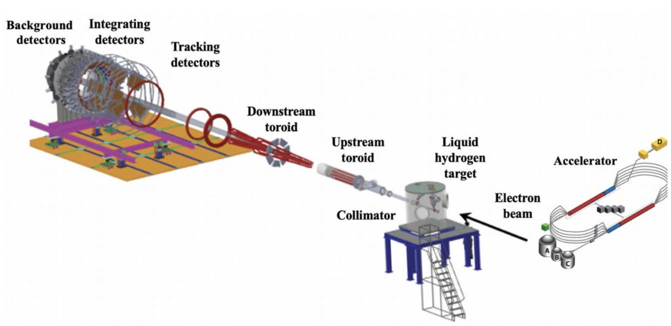

Figure 11-1: MOLLER experiment overview: Layout of the target, spectrometer and detectors

Integrating detectors measure the asymmetry of both signal and background. They are arranged in six concentric rings. Ring 5 captures the Møller electron signal, and the other rings measure various combinations of signal and background processes. Background components are coming from sources other than target electrons. The dominant sources are due to electron-proton scattering in the liquid hydrogen which causes pion production through processes such as inelastic and deep inelastic scattering. These parameters contribute to the correction of A_{PV} . As a part of background events, charged pions contribute to the measurement of the background fraction and asymmetry of the signal. The dedicated pion detector system operates in the integrating mode during the main data-taking to measure pion asymmetries, and in the low-current counting mode to measure the pion background fraction. It is located in the shadow of the Møller ring 5, and behind a lead donut (Pb absorber) to suppress the Møller electrons by more than a factor of 10^3 and retain the pions to detect a roughly equal mixture of pions and Møller electrons. In the original geometry, the ratio of the pions to Møller electrons was of the order 10^{-3}. To achieve the goal, the optimal geometry and position of the pion detector system to maximize the signal from pions were determined and the results from the simulations were verified by cosmic testing of the first prototype at the University of Manitoba, and beam tests carried out at MAMI-B microtron in Mainz, Germany. After two years of optimization processes, the finalized design of the pion detector system, shown in Fig 11-2, was able to achieve pions to Moller electrons rate ratio of ~1.

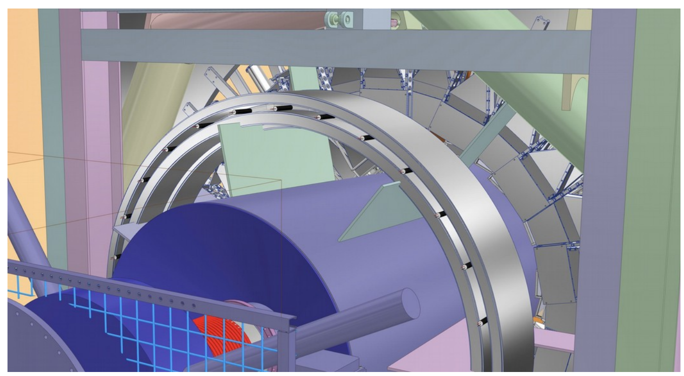

Figure 11-2: Finalized pion detector system integrated with the lead donut

The finalized design includes 28 acrylic Cherenkov detectors, each with a photomultiplier tube (PMT). The original design had 14 detectors and three PMTs per detector. All detectors have also been turned 90 degrees in order to line up with the beam's direction. It has been shown that this rotation causes a three-fold increase in the number of collected photoelectrons in both cosmic and beam testing. Previously, the lead donut and pion detector system were two separate parts. To protect the pion detector system against low-charged particle showers, it is integrated with the lead donut. Recently, The prototype mechanical design has been completed at the University of Manitoba and has been handed over to MOLLER's engineers for further evaluation. This is the final step in the process. We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC) and Canada Foundations for Innovation (CFI).

12. Electron Cyclotron Resonance (ECR) Magnetometry for Gravitational Experiments with Antihydrogen in ALPHAg

Adam Powell (Calgary)
PhD Supervisor: Timothy Friesen (Calgary)

The imbalance in matter and antimatter in the universe is a major puzzle in physics. The study of antihydrogen, and subsequent comparison with hydrogen, provides the perfect test bed for fundamental theories and in a search for an answer to this baryonic asymmetry problem.

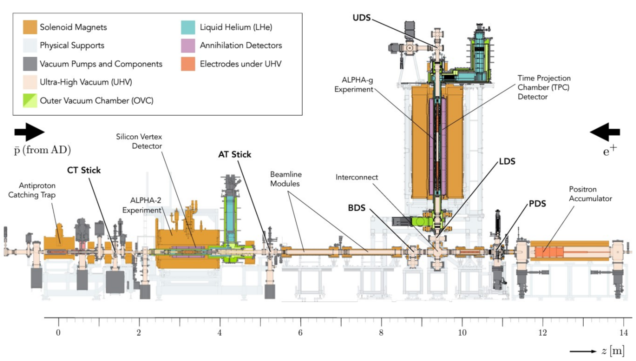

Figure 12-1: A schematic of the whole ALPHA experiment highlighting the sources of antiprotons and positrons. The ALPHA2 spectroscopy apparatus is shown as well as the newly built ALPHA-g.

ALPHAg is a recently constructed experiment at CERN with the goal of measuring the gravitational free fall of antihydrogen through the slow release of magnetically confined atoms. The design of the experiment is based on the successful ALPHA spectroscopy apparatus [ALPHA collaboration, Nature volume 557, pages71–75 (2018)] but with a vertical orientation to provide a difference in height, and therefore potential, across the antihydrogen trap. The difference in potential across the trapping region is equivalent to a magnetic field difference of 4×10^{-3} T. Due to the large magnetic field gradient required to trap antihydrogen, the field change during a slow release is approximately 0.7 T. It should be clear that magnetic fields must be controlled and measured to a high precision, this is challenging when many superconducting magnets are required for confinement. The whole ALPHA experiment can be seen in Fig 12-1.

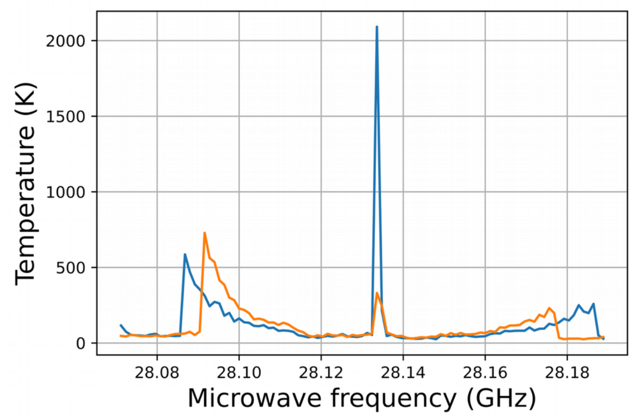

Figure 12-2: Two example ECR spectra showing heating of electron plasmas around the ECR frequency with broad sidebands due to axial particle motions. The axial motion frequency has been adjusted between spectra by changing the electrostatic confining well. Each spectrum consists of 100 temperature measurements.

In the past year, as a CINP graduate fellow, my research focus has been magnetic field measurements for ALPHAg using electron cyclotron resonance (ECR) magnetometry. Since charged particles in a magnetic field oscillate with a cyclotron motion with frequency, $f_c = \frac{qB}{2\pi m}$, if one can probe this frequency the magnetic field is easily calculated. For electrons in a 1 T field, this cyclotron frequency is around 28 GHz, a microwave frequency that can propagate in the ALPHA penning traps. Using small electron plasmas produced in rapid succession and a frequency sweep one can probe this frequency and corresponding field in a range of settings and applications [Hunter et al, Physics of Plasmas 27, 032106 (2020)]. Each electron plasma is irradiated with a different microwave frequency, the temperature is destructively measured, and heating is observed around resonance and with sidebands at an axial motion frequency, examples can be seen in Fig

12-2.

To confirm the magnetic fields are controlled and understood better than the required precision an extensive characterisation of the magnetic environment has been undertaken.
Firstly, we examine the position of the antihydrogen trapping magnets relative to the penning trap and the annihilation detector by manipulating the electrons position in the penning trap. This is followed up with characterisation of any persistent currents, and their change over time, in nearby super conducting materials during as magnetic fields are changed. Additionally, reproducibility of the changing field is closely examined along with several other systematic effects. Following this work, we can measure the magnetic field at the necessary precision in the necessary conditions.

13. International Accelerator School
submitted by Mark Boland (Saskatchewan)

On behalf of the organizing committee and the Canadian Light Source, we are pleased to welcome you to the International Accelerator School being held in Saskatoon. The meeting website is: https://indico.lightsource.ca/event/6/

The Joint Accelerator School (JAS) has historically organized topical courses at regular intervals on accelerator beam dynamics or special technologies in the field of accelerator science and technology. Since new member states have joined the effort, the school has been given a new name: International Accelerator school (IAS).

Like the JAS, the IAS will foster a collaborative atmosphere amongst the global accelerator communities and provide educational opportunities for young scientists and engineers in the fast growing field of particle accelerators.

The Canadian Light Source (CLS), in collaboration with TRIUMF and CERN, is hosting in Saskatoon the IAS 2023 course with the theme of Superconducting Science and Technology for Particle Accelerators. The course program will cover lectures on superconductivity and its application to the main accelerator technologies, including RF, Magnets and other ancillary engineering systems. The course program will be complemented by case-studies and so-called Hands-On courses, during which students can interact with real measurement equipment.

There will also be some lectures specific to the Electron-Ion Collider (EIC).

The course program covers from introductory level concepts up to detailed specialized topics. For this reason, graduate students, post-doctoral fellows and laboratory employees will be able to benefit from the course.

The organization team will implement very strict sanitary measures in order to ensure the health and safety of all participants due to risks of the Covid-19 pandemic. Since the conditions are likely to change over the next months, the applications for places in the course will be initially only be considered as expressions of interest until a very late final deadline. Only shortly before the course will applications become a formal commitment to attend the course.

We look forward to meeting you and learning with you.

Hosted by:
Canadian Light Source
In Collaboration With:
TRIUMF
CERN
University of Saskatchewan
Universität Hamburg
Endorsed by:
IUPAP

14. TRIUMF Science Week
submitted by Annika Lennarz (TRIUMF)

We are pleased to announce that registration is now open **for TRIUMF Science Week 2023, July 31 — August 4.**

TRIUMF Science Week is a yearly event that brings together the laboratory community to learn about updates to, and importantly, to seek community input and initiate inter-disciplinary discussions on the TRIUMF science program. Please visit the Science Week website for the preliminary program, including planned social and networking events.
This year's program is taking shape and will feature presentations on recent achievements and science highlights and will provide an opportunity for Early Career Researchers to present their research. Following on from last year's event where input and feedback from the TRIUMF community on major science directions and initiatives were gathered for our 20-Year Vision, Science Week 2023 will also serve as a platform to discuss and solicit feedback on the key themes and approaches being envisioned for the next five-year proposal for operational funding (2025-2030). With ARIEL on the horizon, one day will be dedicated to informing the community about the facility's status and timelines, as well as to present and discuss exciting new science opportunities with the facility.

As an important summer networking event, several in-person social gatherings are being planned for Science Week, such as the TRIUMF summer BBQ, networking opportunities for students and postdocs, and sporting events. In addition, the TRIUMF Users Group (TUG) Annual General Meeting will take place at the end of the week. Arrangements will be made for remote participants to connect and join the discussions as well.

Important notice for students and postdocs: *If you would like to participate in either the poster session or the Talk competition, please register* ***before Monday, June 19th, 2023,*** *and make sure to indicate your interest at the time of registration. We will contact you with further details shortly after the registration deadline.*

At present, the program is planned as follows:

Monday, July 31^{st}

- Welcome session
- Accelerator Science, Life Science, Nuclear Physics and Molecular & Material Physics Symposia
- Welcome Reception

Tuesday, August 1^{st}

- Particle Physics Symposium
- Equity, Diversity & Inclusion workshop
- Scientific Computing and Science & Technology Symposia
- Student competition
- Soccer Tournament

Wednesday, August 2^{nd}

- Five-Year Plan - status update & process
- Five-Year Plan - Divisional planning updates
- Panel: "Reducing our environmental impact"
- Panel: "Indigenous in STEM"
- Poster session

Thursday, August 3^{rd}

- ARIEL DAY
- Status updates & timelines
- Science Opportunities with ARIEL
- Industry panel - networking & career opportunities (GAPS)
- Science week BBQ

Friday, August 4^{th}

- TUG AGM
- Networking Workshop (GAPS)
- Concluding remarks
- Tour (optional)

If you have questions or suggestions, please contact **triumfsw@triumf.ca**.

15. JLab Eta Factory (JEF)
submitted by Zisis Papandreou (Regina)

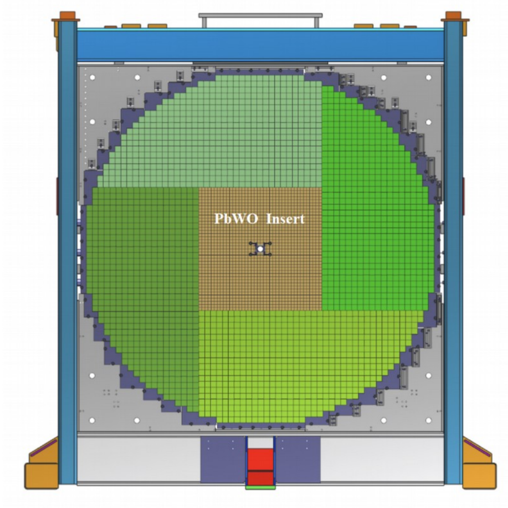

Figure 15-1: Schematic of the JEF Forward Calorimeter (FCAL)

The GlueX Experiment at Jefferson Lab has been operating since 2017, and has collected almost twenty petabytes of data. Its forward calorimeter (FCAL) consists of 2,800 lead glass blocks and is currently being upgraded to include an array of 1,600 radiation-resistant lead tungstate crystals in its central region, as shown in the detector drawing, Fig 15-1. This is a 12-month project, that involves unstacking all existing blocks and restacking the blocks and crystals in a careful manner, taking into account all tolerances and avoiding damage to the crystals. The work started the first week of May (see Fig 15-2). Eleven undergraduates (including two NSERC USRA students from Regina) together with a team of engineers, technicians and scientists are working together, to tackle every detail from preparing new cables, labelling all components, and testing new PMT dividers and a fiber-base light monitoring system. Once competed, GlueX will resume running together with JEF.

The JLab Eta Factory (JEF) experiment will involve precision measurements of η and η' rare decays, which will be measured with the high-granularity high-resolution PbWO4 crystal core in the central FCAL region, which minimizes shower overlaps and optimizes the energy and position resolutions. Access to η and η' decays provides a rich flavour-conserving laboratory for new physics beyond the Standard Model (SM): JEF will facilitate the search for gauge boson candidates in the sub-GeV mass range, probing highly motivated portals coupling the SM to the dark sector. The motivation stems from observed anomalies (e.g. high-energy cosmics rays described by dark-matter annihilation, ^{8}Be decay and dwarf galaxies, among others). As an example, within 100-days of running, JEF will improve the sensitivity in the parameter space of the B' leptophobic vector boson by two orders of magnitude thereby accessing the baryonic fine structure constant α_B down to 10^7, indirectly constraining the existence of anomaly cancelling fermions at the TeV-scale. JEF will constrain C-violating P-conserving physics and also test the isospin-violating sector of low-energy QCD: $\eta \to 3\pi^0$ decay for the quark mass ratio, and $\eta \to \pi^0\gamma\gamma$ for O(p6) for chiral perturbation theory tests.

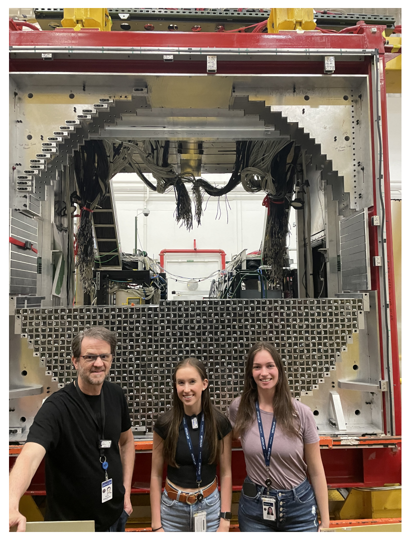

Figure 15-2: ZP with Regina NSERC USRA students Madelyn K and Madison B, who are spending their summer at Jefferson Lab

Conventional and ML algorithms for photon reconstruction towards minimizing shower overlaps/mergers in the FCAL are being employed. In addition, hadronic splitoff events must be distinguished from photon showers in developing a shower quality factor. We are extending this to the finer granularity in JEF, with the challenge of "stitching" the boundary between the central PbWO4 and outer Pb-glass regions. Suitable event samples are being prepared to train and test the ML algorithms, with a key one being a hierarchical clustering algorithm. Such work is applicable to the EIC Calorimeters.

16. Electron-Ion Collider (EIC) Electromagnetic Calorimeter (ECAL)

submitted by Zisis Papandreou (Regina)

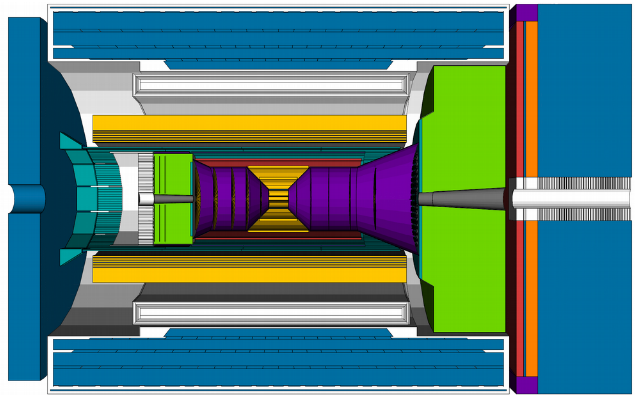

Figure 16-1: Schematic of the ePIC (electron Proton Ion Collisions) detector

The physics goals at the Electron-Ion Collider lead to unique requirements for electromagnetic calorimetry (ECAL) in the barrel region of the detector. The electron energy and shower profile measurements in the ECAL play a crucial role in the separation of electrons from background pions in Deep Inelastic Scattering processes. The calorimeter must also measure the energy and coordinates of photons, and identify single photons originating from, e.g. the Deeply Virtual Compton Scattering process, and photon pairs from the production of π^0s and their subsequent decays.

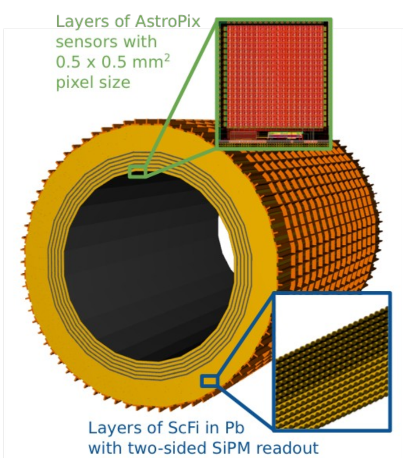

Figure 16-2: Detail of the imaging barrel electromagnetic calorimeter (bECAL)

A USA-Canada-Korea collaboration, with Canadian groups from U Regina, U Manitoba, Mt. Allison U, is carrying out an R&D program focused on an imaging calorimetry concept for the Electron-Ion Collider in the barrel region. This exciting new design is based on solid understanding of the technological capabilities and associated group expertise, and was recently approved to be included in the baseline Detector #1, termed ePIC. A schematic of the ePIC detector is in Fig 16-1, with the imaging calorimeter barrel (bECAL) detail (Fig 16-2) showing the position sensitive silicon detectors and the lead-scintillating-fiber matrix. The latter is based on the successful e-m barrel calorimeter (BCAL), which was built at U.Regina for the GlueX experiment at Jefferson Lab. Preliminary designs for bECAL require 5,600 km of 1-mm-diameter fibres and 3,400 silicon photomultipliers (SiPMs), and the device could weight close to 50 tons. The position sensitive silicon detectors have very good energy resolution, exceptional position resolution, and are characterized by very low power dissipation that makes them the idea sensor for this application.

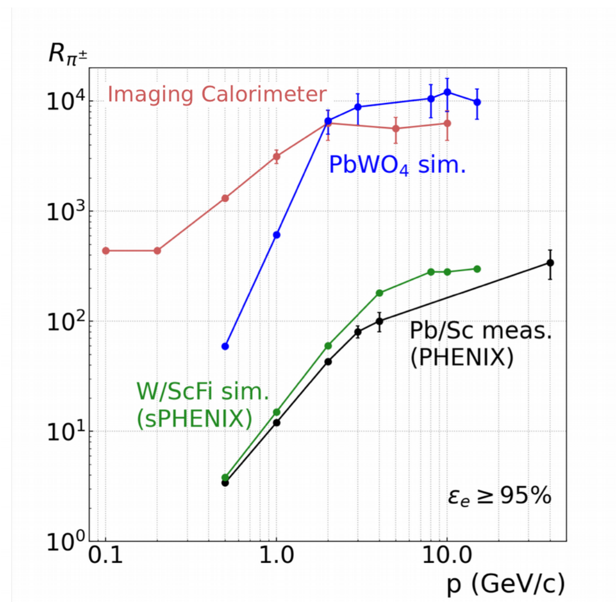

Figure 16-3: Electron/pion suppression simulations for the ePIC bECAL

The technology will allow for an accurate 3D imaging of particle showers by combining energy profiles, obtained with lead and scintillating fiber (Pb/ScFi) layers, with precise particle positions and single-hit energy information from several interleaved layers of monolithic silicon AstroPix sensors (similar to those for NASA's AMEGO-X mission). This design provides considerably more information compared to traditional 2D calorimeters. The 3D nature of the images synergizes particularly well with event reconstruction approaches based on Machine Learning/Artificial Intelligence (ML/AI). This technology improves significantly the particle identification capabilities. For example, realistic simulation studies of AI/ML-based electron-pion separation (Fig 15-3) show best-in-class performance at lower particle energies, while providing comparable results to state-of-the-art crystal calorimeters at higher energies at a significantly lower cost.

The generic R&D related to the hybrid imaging calorimetry for EIC calls for investigations of the Pb/ScFi and Astropix sensors technologies, as well as their integration. We plan to focus on questions targeting the ScFi technology, verifying with experimental data that it is capable of providing the required energy resolution in the barrel region of any EIC detector concept, as well as the position resolution crucial for position-matching of the clusters reconstructed from the imaging layers with the clusters from the Pb/ScFi section of the calorimeter. This work is being carried out with beam tests at Jefferson Lab and Fermilab in 2023-2024. The US Department of Energy expects to award Critical Decision 3 in 2025, which will likely entail early procurement of fibres and silicon photomultipliers, as these are classified as long-lead items due to vendor production capabilities.

17. Grad classes offered by TRIUMF

(submitted by Marcello Pavan, TRIUMF)

TRIUMF periodically offers a few graduate-level courses, usually in the fall and winter terms, which could be of interest to your students. The courses are run online through UBC or UVic. Typically students would register at their local department in a 'directed studies' or 'special topics' course, though students in western Canada could take advantage of the Western Dean's Agreement to transfer course credit directly.

In Winter 2024, the following courses are planned. Students are asked to contact the lecturer directly is they are interesting in taking, or want more information about, the course.

UBC PHYS 560 / UVic PHYS 522 Physics and Engineering of Particle Accelerators

The course will provide an introduction to the physics and technology of particle accelerators concentrating particularly on proton and ion accelerator technology. The course will include a survey of existing accelerator types and an introduction to transverse and longitudinal beam optics. The course will also include an introduction to the physics and technology of ion sources, will give an overview of radioactive ion beam production, of accelerator radio-frequency principles and more detailed aspects of room temperature and superconducting linear accelerators, as well as high energy circular machines. The course should appeal to students of Accelerator Physics, as well as to students of Experimental Nuclear and Particle Physics and other students interested in Particle Accelerators.

Pre-requisites: Classical Mechanics, Classical Electro-dynamics

Contact: Dr. Oliver Kester <okester@triumf.ca>

UBC Phys 527 Advanced topics in Nuclear Physics

This is a graduate-level nuclear physics course for graduate students across Canada who already have taken introductory nuclear physics. The course will be delivered in hybrid/online form. It will survey topics of current interest in the fields of nuclear structure and nuclear astrophysics. Course content details will be available in Fall 2023.

Contact: Marcello Pavan <marcello@triumf.ca>

UBC PHYS 528 Elementary Particle Physics

(to be offered ONLY if there is sufficient demand)

https://particletheory.triumf.ca/PHYS528/

This course will cover the underlying theory of the Standard Model (SM) of particle physics. Starting from Feynman diagrams and quantum electrodynamics (QED), we will build up the other elements of the SM including the strong and weak forces and the Higgs mechanism. We will also connect the SM to experimental observations at high energy colliders and beyond.

This course may be offered if there is sufficient interest.

Prerequisite: Familiarity with QED at the level of tree-level Feynman rules.

Contact: Dr. David Morrissey <dmorri@triumf.ca>

18. CINP posting of Job Opportunities

We regularly post Nuclear Physics Job Opportunities on the CINP website, at:
https://cinp.ca/announcements

- Researchers looking for positions are encouraged to regularly consult this page. Please let the Executive Director know if you are recruiting for a position and want your announcement to be distributed.

19. CINP Board of Directors

The CINP Institutional Members had their annual meeting via Zoom on May 18. One of the agenda items was to elect two Board members, who are listed below. Their assigned duties will be selected at their next meeting on June 22.

Name	Institution	Email	Term Ends
Thomas Brunner	McGill	thomas.brunner @ mcgill.ca	June, 2025
Liliana Caballero	Guelph	ocaballe @ uoguelph.ca	June, 2026
Gwen Grinyer	Regina	gwen.grinyer @ uregina.ca	June, 2024
Rituparna Kanungo	Saint Mary's	ritu @ triumf.ca	June, 2025
Russ Mammei	Winnipeg	r.mammei @ uwinnipeg.ca	June, 2026
Chris Ruiz	TRIUMF	ruiz @ triumf.ca	June, 2024

CINP Executive Director:

If you require information about any CINP programs, please do not hesitate to contact:

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CINP Treasurer:

Greg Hackman
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CINP Institutional Members:

Memorial University of Newfoundland
Saint Mary's University
Mt. Allison University
McGill University
University of Guelph
University of Manitoba
University of Winnipeg
University of Regina
University of Northern British Columbia
Simon Fraser University
TRIUMF

Scientific Working Group Chairs:

Fundamental Symmetries:
Gerald Gwinner(Manitoba)
Hadronic Physics/QCD:
Svetlana Barkanova (Memorial)
Nuclear Astrophysics: Iris Dillmann (TRIUMF)
Nuclear Education and Training:
Juliette Mammei (Manitoba)
Nuclear Structure: Adam Garnsworthy (TRIUMF)
Nuclear Theory: Alexandros Gezerlis (Guelph)

This Newsletter was edited by Garth Huber. Email regarding the content of this newsletter, or suggestions for content in future CINP newsletters should be sent to huberg@cinp.ca